

PROJECT CRAFTeD: AN ADAPTED LESSON STUDY PARTNERING PRESERVICE MATHEMATICS TEACHERS WITH A MASTER TEACHER

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Reports on a research project designed to implement an adapted Lesson Study cycle whereby preservice mathematics teachers co-create a lesson with a Master Teacher and observe the Master Teacher teach the lesson. Results show the preservice teachers' shift, when designing a lesson, from a 'teacher presenting the task' perspective to a 'student engaging in the task' perspective and the importance of seeing their own lesson taught.

Introduction

This paper reports on a study designed to show how an adapted Lesson Study (Isoda, 2007) can enhance preservice teachers' early experiences in constructing mathematical tasks for use in the classroom. For the purposes of this study, the term Lesson Study refers to an improvement cycle in which teachers collaborate to discuss learning goals and plan one or more actual classroom lessons. Teachers engaged in lesson study assume shared responsibility for the teaching lessons they create, observe the effectiveness of these materials as they are taught, and then work to revise lessons for future use (Lewis, 2002).

Specifically we studied a community of planning and practice (Wenger, 1999) by implementing and studying a cycle of preservice teachers designing lessons which promote inquiry and learning for understanding; the implementation of those lessons by a Master Teacher (observed by the preservice teachers); and co-reflection on the lesson by the inservice and preservice teachers. We call this the CRAFTeD (Call for lesson; Referendum, Advising session; Fine-tune; Teach-Experience; Debrief) cycle. The key component of this cycle is that preservice teachers see *their own* Lesson Plan implemented by a Master Teacher which gives them a different level of investment in the lesson than if they watched exemplary lessons, and they see their Lesson Plan implemented without having the pressure of teaching the lesson themselves whereby their concentration may be such aspects as classroom management, teaching style and their interactions with the students.

In pilot studies undertaken in the past (Meagher, Edwards & Koca, 2009) we have seen the importance of exemplary field placements for the consolidation of issues about inquiry learning addressed in the university classroom. The use of video technology in our most recent work has shown how the school-university partnership has the possibility be scaled up to impact far more preservice teachers than are able to attend a field placement site.

The research questions guiding the research and the analysis are:

- (a) How do preservice teachers engage in creating lessons with a Master Teacher?
- (b) What is the impact on preservice teachers of seeing *their own* lesson being taught?

Literature Review and Relationship to Research

There is now a large body of literature (Conference on Learning Study, 2006; Fernandez, Cannon & Chokshi, 2003; Fernandez & Yoshida, 2004; Isoda, 2007; Lewis, Perry, & Murata, 2006) on the importance and effectiveness of Lesson Study approaches in improving teaching,

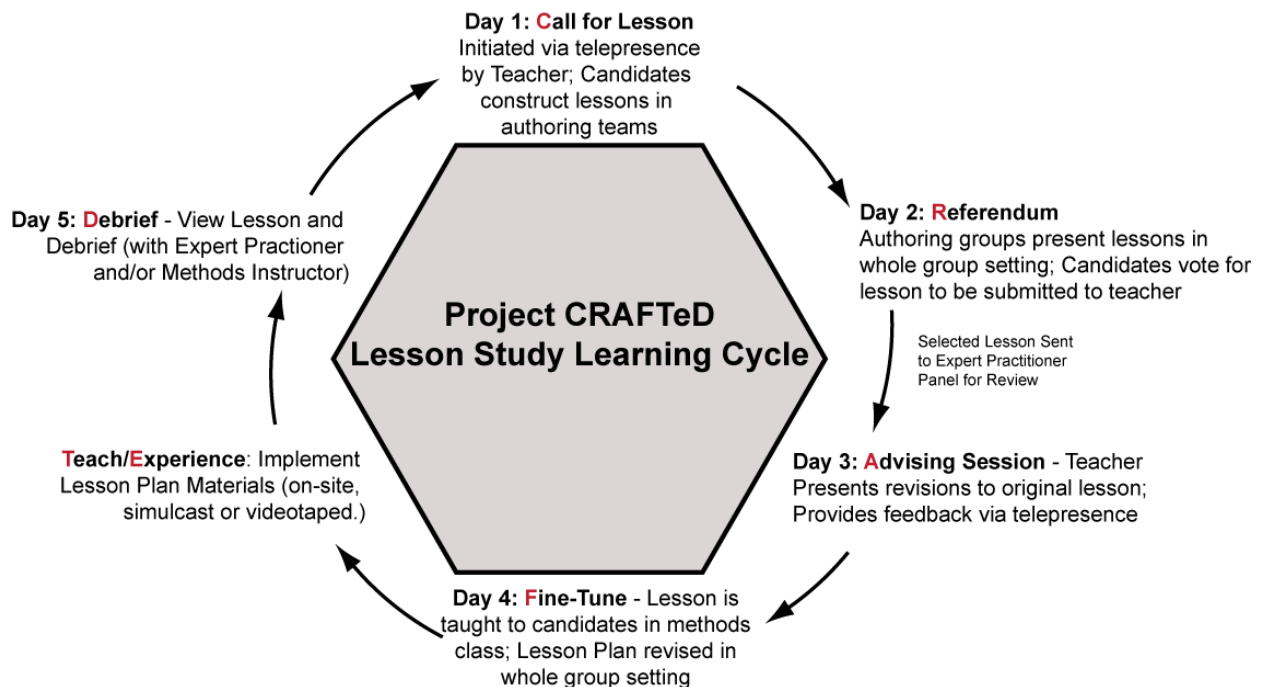
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curricular content, and instructional sequences. Hart, Alston & Murata (2009) draw on a plethora of research studies to argue that while many Professional Development models such as action research or teacher place teachers at the centre of the research, Lesson Study is unique in focus that is brought to bear on a “live lesson.” They assert that “teachers notice certain aspects of teaching and learning, and this implicit and organic noticing does not happen in artificially replicated professional development settings.” (p.1) Lesson Study approaches can also provide for more focused professional development than many traditional professional development models (Lewis, 2002). Furthermore, developing communities of practice (Wenger, 1999) and lesson study groups (Fernandez, 2002) can help teachers to adopt a more research-based focus in their lesson planning and to develop a shared repertoire of communal resources which can transcend individual contributions. Most research thus far has focused on inservice teachers: our research involves implementing an adaption of the Lesson Study approach for pre-service teachers.

Our research employs lessons learned from Lesson Study approaches to address the problem that the teaching methodologies advocated by methods instructors in teacher preparation programs are not readily observed in actual classroom settings, a disconnect that has become more pronounced in the age of high-stakes standardized testing. While university methods instructors laud the merits of student-led inquiry, exploration, and discovery-based teaching methods, secondary mathematics teachers in too many schools “set aside” such teaching in favor of instruction directly focused on student preparation for high-stakes, multiple choice state tests (Seeley, 2006). In an age in which testing dominates the landscape of too many classrooms, it becomes increasingly difficult to provide teachers-in-training with models of high-quality mathematics instruction in secondary school environments. The proposed study looks to explore an answer to this situation by providing preservice teachers with opportunities to collaborate with exemplary high school mathematics teachers by means of inexpensive, readily available web-based conferencing services and strategic face-to-face visits throughout the semester.

Methods and Methodologies

This research is designed to implement the following CRAFTeD cycle:



The cycle emerged from our previous work where the decisive influence of the field placement in terms of the mentorship/exemplars students experienced became apparent.

(i) A class of preservice high school teachers wrote Lesson Plans on a given topic and then worked together to develop improved lessons/short units designed often for technology-rich environments; (ii) an experienced inservice teacher reviewed the lessons/short units and presented an initial redesign; (iii) the inservice teacher taught the lesson, observed on video by the preservice teachers; (iv) the preservice teachers and inservice teachers met together to reflect on and redesign the lesson based on their experiences in the classroom

The purpose of the cycle is to examine (i) how pre-service teachers co-create a lesson and (ii) to examine the particular impact of ownership of the lesson on preservice teachers learning.

The preservice teachers

The pre-service teachers (n=15) were engaged in routine activities that comprise a mathematics teaching methods course, which met for two 75 minute sessions a week for 15 weeks, at a small Midwestern university. The course was the second in a two-course Methods sequence, these courses being the pre-service teachers' only Methods courses in the program. Prior to taking the Methods courses the pre-service teachers take Foundations and Mathematics Content courses. The course was designed specifically for pre-service secondary school mathematics teachers, with the subjects engaging in activities focused primarily on pedagogical issues (e.g. constructing lesson plans and grading rubrics, creating technology-oriented math activities) and content issues (solving mathematics problems, assessing student work). As part of the course the preservice teachers engaged in two iterations of the CRAFTeD cycle.

The inservice teachers

The inservice teacher was a Master Teacher at a local partnering school. The inservice teacher has been a co-operating teacher with the university for many years and is a teacher leader in the district with particular expertise in the use of technology in teaching mathematics.

Data Collection

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The data collected during each cycle, as described above was

- A Skype-based discussion between the class and the inservice teacher initiating the cycle
- Lesson Plans created by small groups of the preservice teachers
- The Lesson Plan voted on as the best from the 8 created
- The revisions suggested by the inservice teacher
- Reflections from the inservice teacher and the preservice teachers on the revised lesson
- The final implemented Lesson Plan
- Videotape and fieldnotes from the lesson as taught by the inservice teacher
- Videotape and fieldnotes of the debriefing between the preservice and inservice teacher.
- Interviews with inservice and preservice teachers on the entire cycle.
- A revised Lesson Plan after the teaching of the Lesson.

The data coded for direct answers to the research questions with two basic codes: “co-creation” (CC) and “*their own* lesson” (TOL). The data was then re-analysed using the constant comparative method (Cresswell, 1998) to examine emerging patterns that were not revealed at the first round of coding. Sub codes such as Modifications to the Lessons, Classroom Management, Student Learning emerged at this stage. Quotes exemplifying the quotes were organised and exemplary quotes for each of the codes chosen to support the analysis. The analysis is presented in the order of the cycle.

Results

Call for Lesson

The cycle was implemented on two occasions in the semester. On each occasion there was a Skype teleconference with the experienced teacher. In the first iteration of the cycle the Call was for a lesson introducing right angle trigonometry in a manner that would allow the students experiencing the lesson to “make a connection to the ‘sin’ button on their calculator.” For the second lesson the Call was for a lesson connecting the unit circle and the sine curve.

Referendum

At the Referendum stage in the first iteration the preservice teachers decided to take elements from each of the group’s lessons to make what they ended up calling the ‘Frankenstein’ lesson. The consensus was that the ‘Frankenstein’ lesson didn’t work as well as it could have so, for the second iteration of the cycle the preservice teachers decided to pick one lesson and then work together to strengthen that lesson.

Advising Session

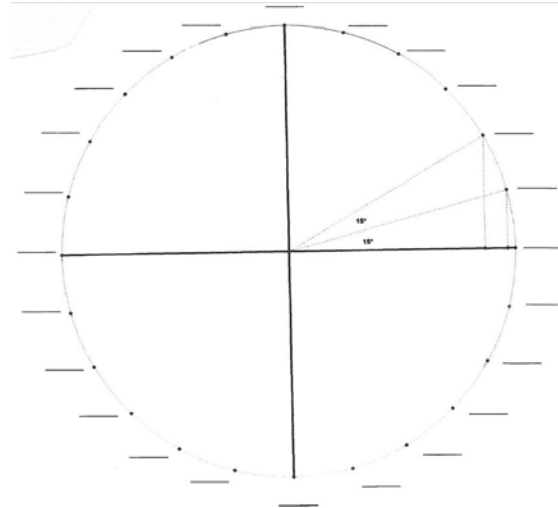
Two candidate lesson’s were sent to the inservice teacher who reviewed both and then chose on commenting “I will use A’s lesson. The other is good, but too algebraic. I really wanted something visual and kinesthetic, and A’s fit the bill.” (Inservice Teacher Interview)

The core of the Lesson chosen is a fairly standard use of pieces of dry strands spaghetti placed on a unit circle to create a physical measurement of the y-coordinate associated with a chosen x-coordinate. Students then paste these pieces onto an axis at the relevant place to create the outline of a sine curve.

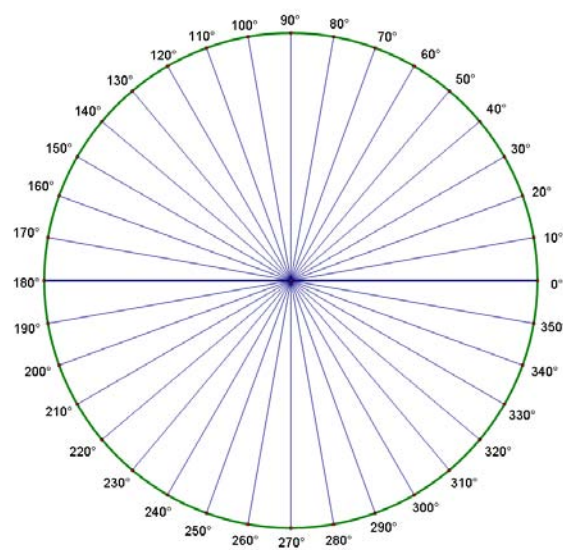
The students sent a complete lesson, including worksheets to the inservice teacher who then return the lesson with several comments. It is interesting to note that many of the modifications made by the inservice teacher at this point showed his experience in thinking about the lesson from a students’ point of view. To use the language of Stein and Schwab Smith (1998) he is thinking about “Tasks as implemented by students” rather than “Tasks as set up by teachers.” Many of the modifications are simply practical elements which the inservice teacher recognises

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as crucial to allowing the students to concentrate on the substance of the task. For example, in the original lesson the students constructed a story about the bug's journey which involved taking measurements every 15 seconds which should then be equated to degrees (the journey having been set up to take 6 minutes so each degree would be a second) resulting in the following unit circle on their worksheet:



with just two indicators each showing 15 degrees. The inservice teacher judged the time issue to be a distraction and also recognised the ambiguity in this set up: Will students recognise that the two 15 degrees indicated are supposed to total to the 30 degrees required for the second measurement? Might students get confused about what happened when you get passed 90 degrees? There are some valuable mathematical discussions possible around those two questions but the inservice teacher wanted the students to concentrate on getting the correct measurements and not be distracted at his point of the lesson and so proposed the following unit circle for the worksheet:



The preservice teachers recognised this as having the advantage of focusing on the degree measurements of the unit circle and therefore being more focused on the substance of the mathematics.

Fine-tune:

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The preservice teachers moved to the fine-tune part of the cycle wherein the authors of the original lesson plan formally taught the lesson to the other preservice teachers. This stage of the process turned out to be surprisingly powerful. It furthered the preservice teachers' development in taking the crucial step of thinking about the lesson from a students' perspective rather than from a teacher's perspective (students' tasks vs teachers' tasks again). Suddenly a plethora of practical issues were brought to light and modifications were made to the lesson as the preservice teachers realised that they had not thought carefully enough about many practical issues such as: "The blank graph also had a suggested location to place tape, which we discovered was problematic because the tape being placed over the x-axis made it difficult to determine the exact location of the x-axis." (Preservice teacher 14). The importance of this fine-tuning stage was discussed at length by most of the preservice teachers in their reflections resulted in statements such as "I think the debugging effort demonstrated the importance of "piloting" one's lesson. It is easy to imagine how smoothly things will be, but until you actually put yourself in the role of the student and follow the instructions and complete the activity, it is difficult to identify potential problems." (Preservice teacher 15).

As we have mentioned before this sort of realisation may read as something that should be obvious to teacher candidates but it was an important lesson for them to learn and a lesson that was only learned because their lesson was actually going to be taught not simply produced as an exercise for a class.

Teach/Experience

The Lessons were taught by the inservice teacher and videotaped so that the preservice candidates could spend adequate time watching and reflecting on the implementation of their lesson.

Debrief

The other stage of the cycle where the benefit to the students was greatest was in the debrief on the Lesson. The debrief was conducted through in class discussion and by having the preservice teachers write reflection papers.

In this part of the cycle we again saw the importance of the lesson being *their own* lesson coming through strongly. The level of investment and, therefore, the level of attention the preservice teachers paid to the lesson seemed to be a direct result of this ownership.

Modifications

The preservice teachers noticed straight away that the inservice teacher modified their lesson by including an introduction on families of graphs such as $|x|$ and x^2 . He then spent some time using a SmartBoard to animate the journey of the bug walking around the circle. He then challenged the students to think about what the graph of the height of the bug relative to the x-axis over time would look like. This introduction and conjecture setting may seem, to any experienced reader, an obvious aspect of any lesson and it may indeed seem like even novice teachers should know to do this but it is interesting to read in the student reflections how powerfully this aspect impacted them. The impact had two aspects (i) the conviction that it improved the lesson and (ii) this gave them an example, in a context, that they were familiar with and of which they had ownership, of how a teacher can draw on students' previous learning, connect to the current topic and force students to think through what the outcome may be to create a *student* investment in the outcome of the lesson. (Will the graph turn out to be a parabola as suggested by one of the students in the class?). In their reflections almost every preservice teacher wrote about these modifications and the impact they had on the lesson. As one preservice teacher reflected: "In the Spaghetti Sine lesson, the inservice teacher had to include a warm-up

since we did not provide one with the lesson. The warm-up he presented was excellent in that it helped students to recall previously learned families of functions as a precursor to the introduction of a new family function, the sine curve. This modification significantly improved the lesson's effectiveness from a constructivist point of view. Students were asked to incorporate new information by layering it upon former knowledge.” (Preservice Teacher 2). The idea of the conjecture also resonated strongly with the preservice as exemplified in the following comment: “Most students predicted that the graph of the bug's height above the x-axis would take the shape of a parabola. Having students predict what this graph would look like was a good idea because it forced students to really contemplate the problem before actually investigating it.” (Preservice Teacher 5).

Classroom Management

As the lesson progressed the preservice teachers had an opportunity to closely observe a Master Teacher at work and see an exemplary implementation of the lesson without having to worry about classroom management let alone implementation. In fact, it gave the students an opportunity to observe how a skilled and experienced teacher used classroom management to further the goals of the lesson and engage with the students. As one preservice teacher noted “One small thing that he did to increase the quality of the lesson was going around and handing out tape to the students as they needed it. This small gesture allowed the inservice teacher to roam the room, checking student progress and answering questions while keeping the order by keeping them seated. Otherwise, the activity would be more chaotic if students were constantly getting up to get more tape. This is a management detail that I am now aware of as I begin my teaching career.” (Preservice Teacher 5). The preservice teachers also observed that the inservice teacher was experienced enough to head off some potential difficulties before they could cause a problem “[He] took care of the issue we were concerned about with having the calculators in the correct mode right away at the beginning of class. By taking care of this before getting into the activity, he prevented the possible disaster that could have occurred later and disrupted the entire class.” (Preservice Teacher 9).

Student Learning

The videotaping of the lesson also allowed the preservice teachers the opportunity to observe the students working on the materials they had created. The ownership here provided a real investment in student learning and the tone of excitement in the reflections as the preservice teachers wrote about how they observed student engagement and learning shows the impact of the cycle on their development as novice teachers.

It was pretty cool to watch kids make connections as they were working. After the slope of their sine graph turned negative, many of them began to see the symmetry in the curve they were constructing. Then when the graph slipped below the x-axis many of them realized they were going to make the same curve but upside down from the first. The coolest connection students began to make though was that they could have cut out multiple pieces at the same time. We could literally hear students coming to this conclusion as we watched the video. As connections were being made we could see the students were adding meaning to what they were doing and that this lesson would be one that they would remember. (Preservice Teacher 1)

This observation of connections the students were able to make was frequently remarked upon. Others were encouraged by seeing that the kind of hands-on lesson advocated for by NCTM (2000) and most professors can work in a real class: “I found the level of student engagement heartening. We have been encouraged to find hands on activities when creating

lessons. We are taught that students learn in stages and that abstraction is the last phase. At the secondary level, I believe teachers expect students to leap to abstraction far too quickly. When this happens, the students do not enjoy the process, and often feel left behind in their thinking. Lessons like the Spaghetti Sine lesson remind me to make the leap more of a step. I hope I never forget this pedagogical reality.” (Preservice Teacher 2).

Discussion

This study was designed to implement the six stage CRAFTeD cycle we developed to provide preservice teachers enrolled in a Mathematics Methods class a rich and meaningful experience in writing lesson plans and to answer the following research questions: (a) How do preservice teachers engage in creating lessons with a Master Teacher? (b) What is the impact on preservice teachers of seeing *their own* lesson being taught?

The study was not on a large scale and was exploratory in nature but the data presented above provides evidence that there is a trajectory of development in understanding Lesson Plans as well as many basic and more nuanced issues of teaching when the CRAFTeD cycle is implemented. The fact of the lesson being taught provides extra motivation “These experiences have made something I wouldn’t have cared about as much more worthwhile. If we had been doing lessons for this class and I knew that all they were going to be: all that was going to happen is that they were going to get graded and I was going to get them back I wouldn’t be as prone to put as much time and effort into it as I am now knowing that this is actually being taught to actual students.” (Preservice Teacher 6). The preservice teachers not only had an investment in what was happening but were able to follow every detail of the lesson closely. “I really appreciate having the extra time to create, get feedback, edit, and then give a final version of our lesson to him before he taught it. This made watching the lesson easier since I *knew* what was happening.” (Preservice Teacher 10). The process can also encourage students to be innovative “being able to think outside the box and come up with these things and have a veteran who has outstanding classroom management skills to implement it helps you feel a little more at ease about thinking outside the box.” (Preservice Teacher 8).

The investment in the lesson the preservice teachers had designed and worked on with an experienced teacher made this a very different experience from creating lessons which will never be taught and a very different experience from simply watching an exemplary lesson on video. We believe the CRAFTeD cycle has considerable potential to provide a variant model on traditional Lesson Study that can be very effective the development of preservice teachers.

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